Investigation of Party Line Voice over Inmarsat's Mobile Packet Data Service (MPDS)

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Motivation – Investigate Affordable Party Line Voice

- Cost vs. performance

GCNSS Demo	• Current circuit based satcom – Long call setup, but good quality from dedicated resources – Expensive dedicated resources even when unused – Circuit must be dedicated to each participant in the party line – Poor party line infrastructure
GCNSS Lab Experiment	• Packet switched – Short resource request cycle, but is not dedicated – Pay for resources used (by the packet) – Resources can be shared by all on a party line – Provides a 10 to 100x efficiency (cost) advantage

- Can cost effective non-dedicated resources provide high speech quality for a party line service in oceanic airspace?
- Inmarsat's Mobile Packet Data Service (MPDS) exists, can be tested now, precursor to future generation BGAN*

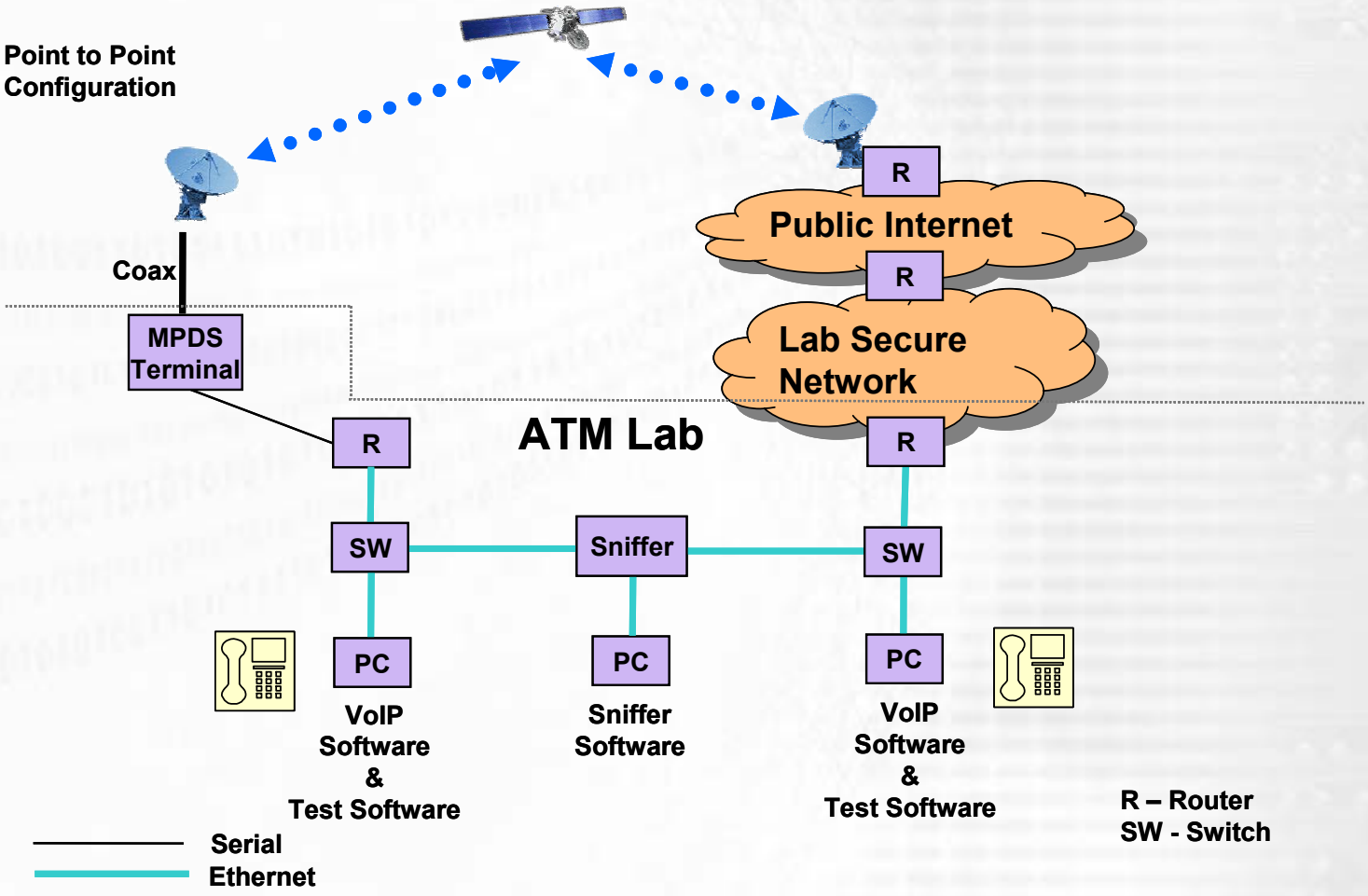
*Inmarsat announced planning timeline pre-operational trials of Aero-BGAN Safety services circa. 2010 during Datalink Users Forum Meeting Feb. 3-5, 2004 San Francisco, CA

Measurement, Simulation, Lab Emulation Synergy

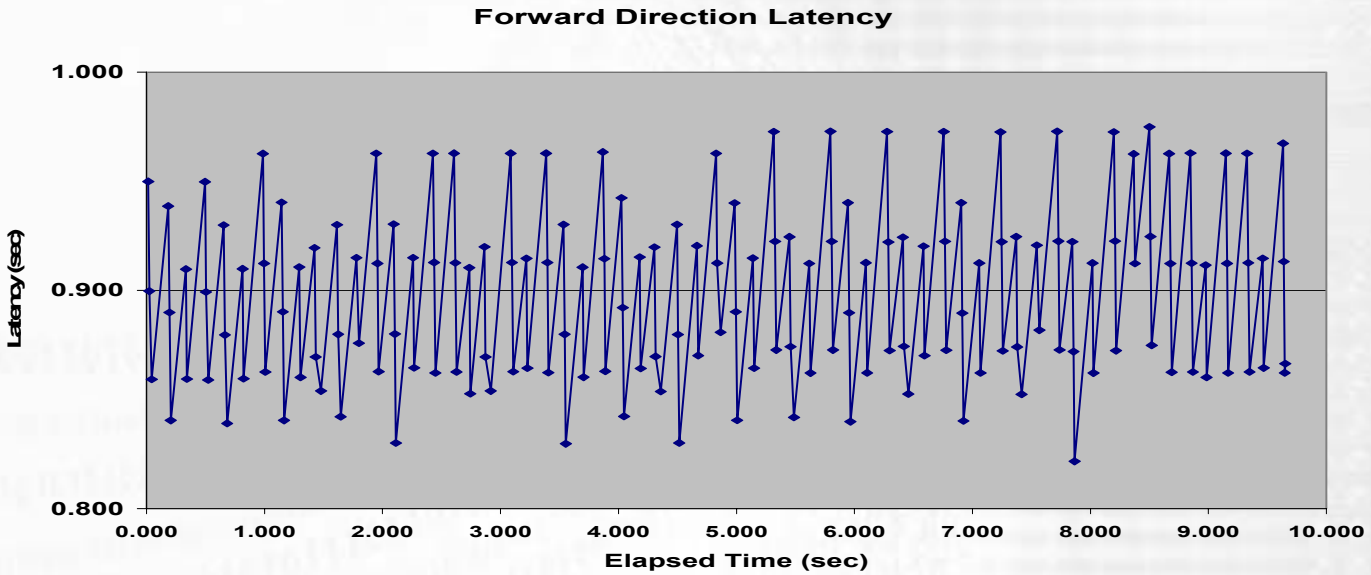
- Experiment
  - Experience and measure VoIP over a packet switched system
  - Validate simulation
  - Includes Internet traversal
  - Limited to single terminal with unknown channel loading
  - Unclear how much of the MPDS SDM* is actually implemented
- OPNET Simulation
  - Based on MPDS SDM to known extent in the simulation
  - Satellite links modeled without the Internet
  - Can extend our analysis beyond SDM for additional capabilities that may be required
  - Capable of modeling multiple terminals
  - Capable of modeling a variety of traffic mixes with control of background traffic
- Basis for hardware/software emulation in laboratory for use in qualitative evaluation of various party line architectures

*Inmarsat MPDS System Design Manual (SDM) provided under NDA

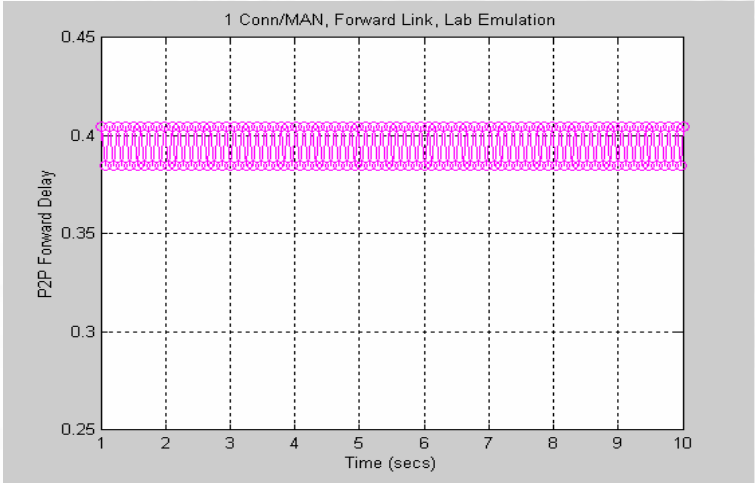
VoIP over Inmarsat's MPDS



Forward Link



- Above: measured packet by packet latency over POR
- Below: simulated latency
- Latency difference due in large part to long terrestrial N.Z. to U.K. path
- Jitter difference unclear but perhaps due to delta between SDM and MPDS implementation or public Internet contribution



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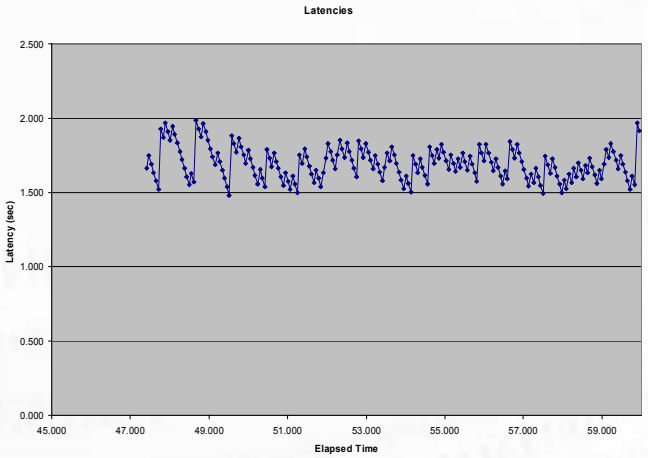
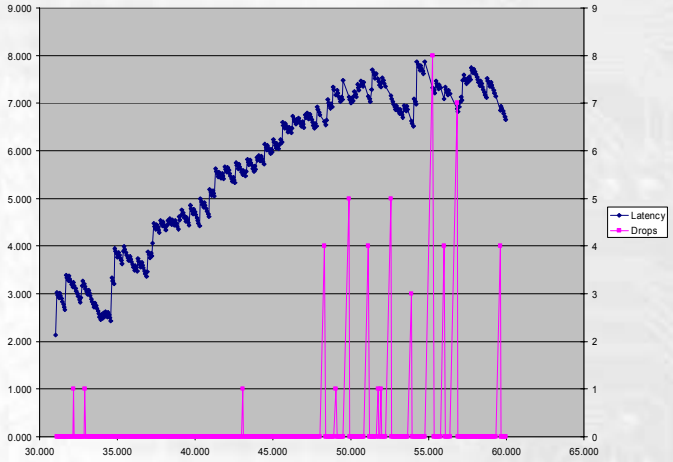
Air Traffic Management

Return Link

Light loading

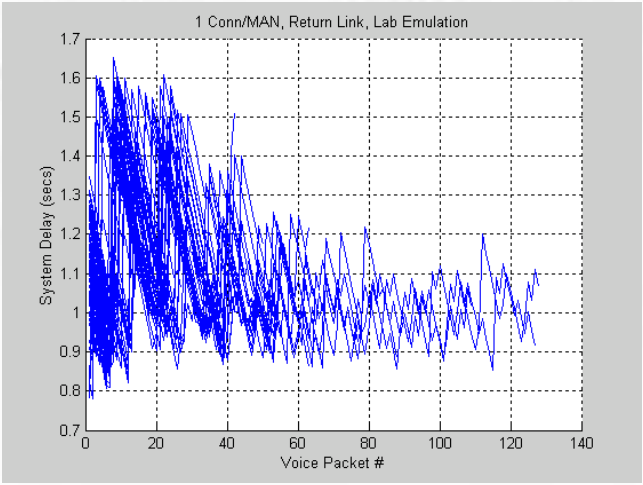


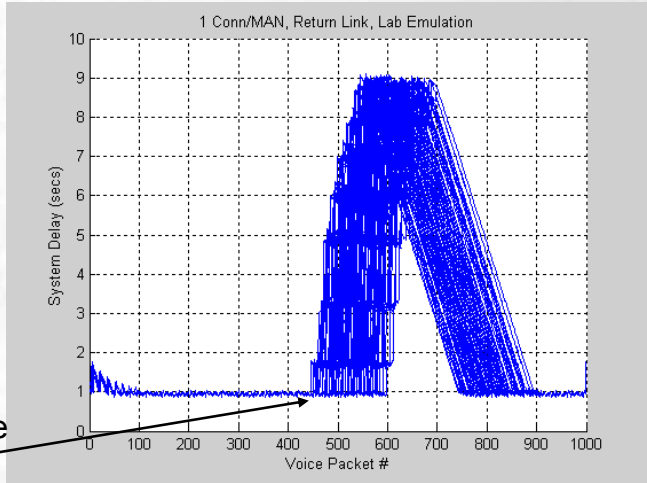
Heavy loading



Measurement

Simulation





Background file transfer

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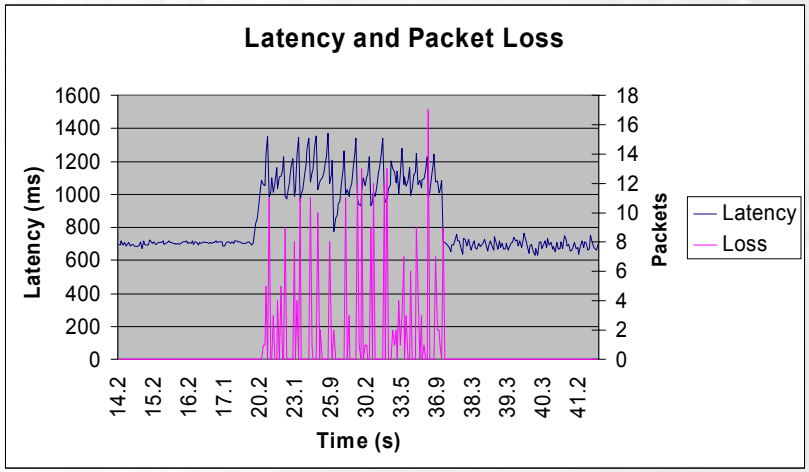
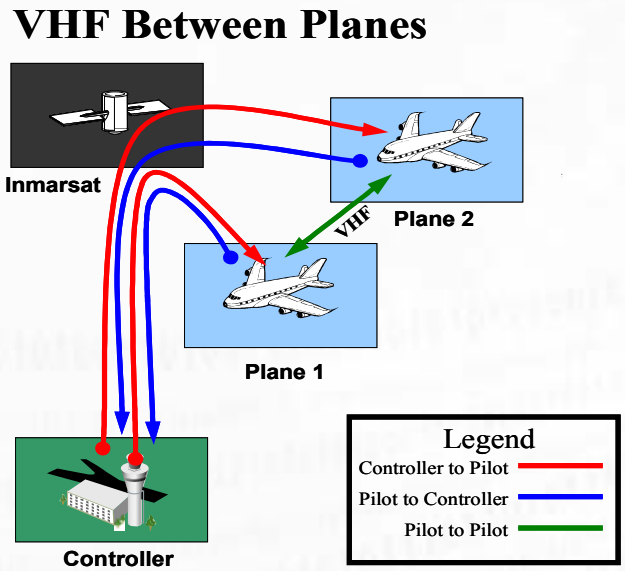
Air Traffic Management

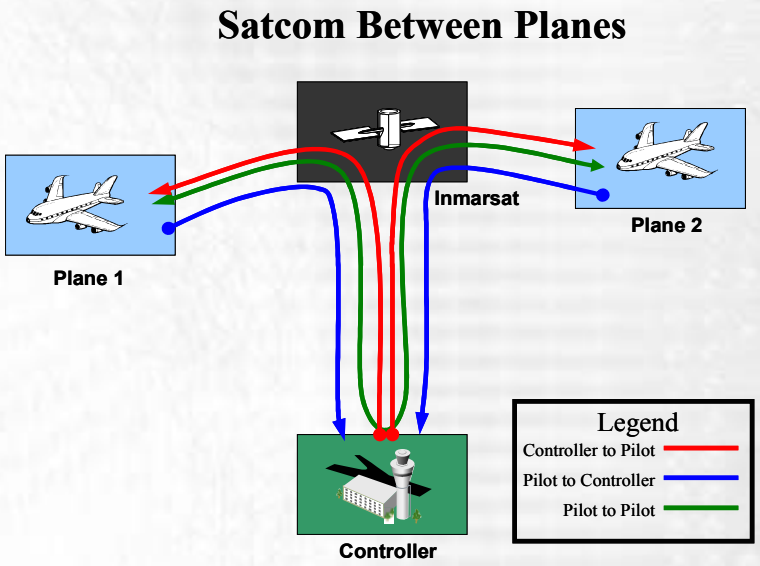
QoS

- Initial steady voice stream
  - 700 ms latency, < 50 ms jitter
- Background file transfer floods link
  - Higher latency and jitter
  - Packet loss
- With link still flooded QoS mechanism turned on
  - 700 ms average latency
  - Jitter 100-150 ms
  - No packet loss



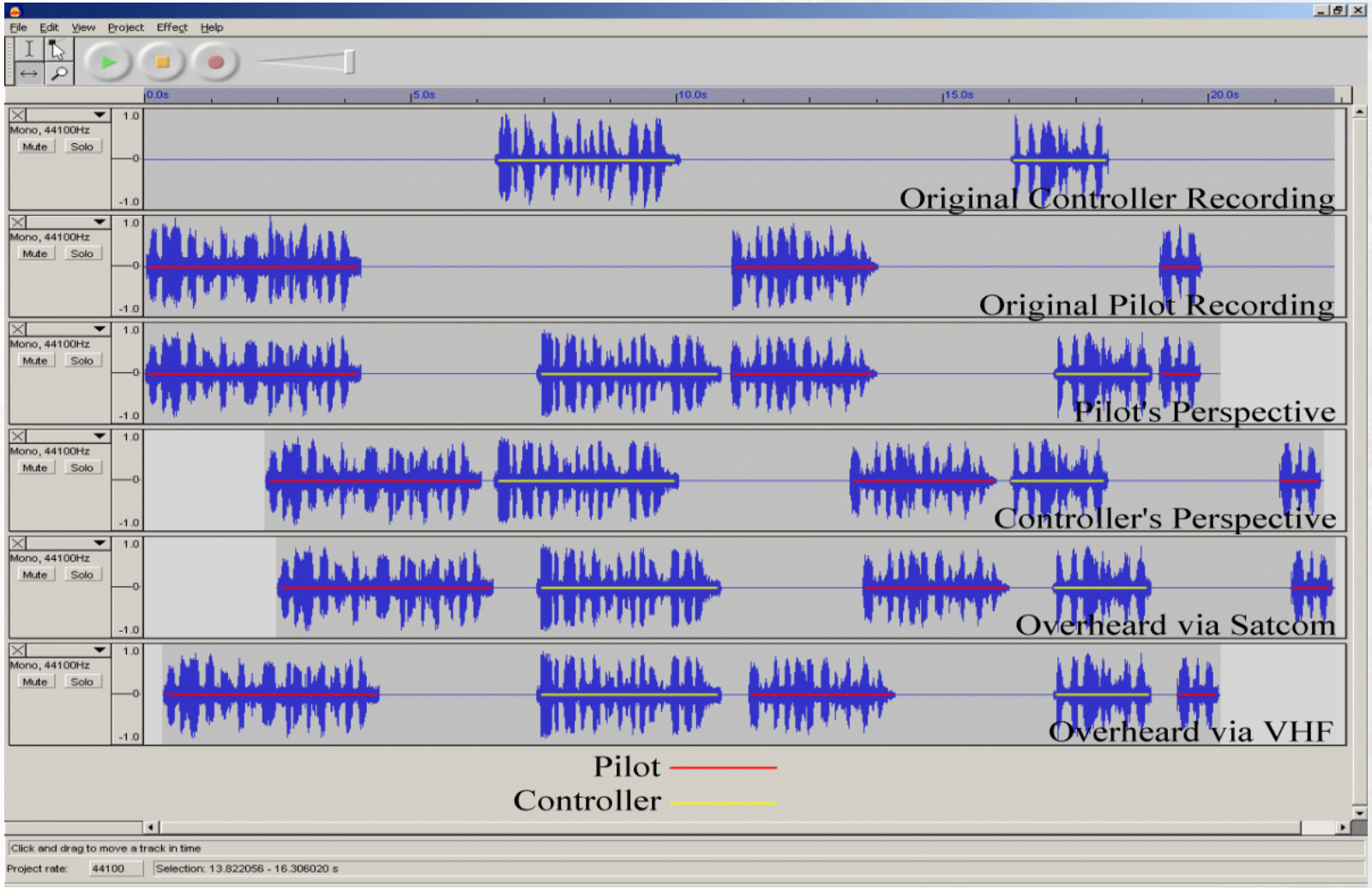
Qualitative Evaluation of Party Line Methods





- Hardware/software emulation of the satellite link based on experiments
- Two latency scenarios considered
  - Current MPDS
  - Improved 'BGAN' values
- Recordings were made representing the asymmetric latency from each participants viewpoint
  - To be heard at the end of the briefing
- An informal lab exercise of the VHF configuration was carried out with in house ex-controllers, and former and current pilots
  - Favorable responses were received for oceanic application despite the noticeable satellite delay.

Recorded Voice Waveforms



Conclusions

- An affordable packet based approach and transition path for offering oceanic and remote party line voice has been identified
- Tests of VoIP over MPDS show promising voice performance when the links are lightly loaded
  - QoS mechanisms, such as may be expected in BGAN, could be used to improve voice quality in more heavily loaded
- Simulations, validated by test results, were used to determine voice capacity of MPDS and explain aspects of the VoIP results
  - Future simulations could model the performance of BGAN QoS alternatives
- Laboratory software/hardware emulation based on testing and simulations was used in the qualitative evaluation of party line concepts
- A human in the loop, voice quality study is needed to evaluate human factors issues for different party line scenarios and architectures.